CLAIMS

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A method for making paper/paperboard, comprising the following steps:

- (a) formulating a first mathematical model of fracture toughness of paper/paperboard as a function of a plurality of variables, each variable representing a respective material property of the paper/paperboard;
- (b) determining a desired fracture toughness value;
- (c) determining respective values for each of said plurality of variables which, when inserted in said first mathematical model, result in a fracture toughness value approximately equal to said desired fracture toughness value; and
- (d) manufacturing a paper/paperboard product having respective material properties represented by respective values that are substantially equal to said determined respective values.
- 2. The method as recited in claim 1, wherein one of said plurality of variables represents filler level.
- of said plurality of variables represents softwood pulp content.
- 4. The method as recited in claim 1, wherein one of said plurality of variables represents caliper.
- 5. The method as recited in claim 1, wherein said first mathematical model of fracture toughness is of the form:

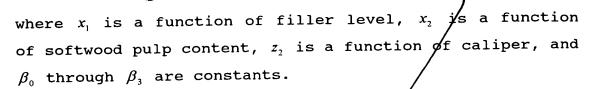
$$FT = \beta_0 - \beta_1 x_1 + \beta_2 x_2 + \beta_3 z_2$$

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- 6. The method as recited in claim 1, further comprising the steps of:
- (e) formulating a second mathematical model of stiffness of paper/paperboard as a function of a plurality of variables, each variable representing a respective material property of the paper/paperboard; and
- (f) determining a stiffness value by inserting values for said variables in said second mathematical model, wherein two of said values were determined in step (c).
- 7. The method as recited in claim 6, wherein said variables used in said second mathematical model represent filler level, basis weight and caliper.
- 8. The method as recited in claim 1, further comprising the steps of
- (e) fortulating a second mathematical model of internal bond of paper/paperboard as a function of a plurality of variables, each variable representing a respective material property of the paper/paperboard; and
- determining bond value by internal an second said variables in said value* for inserting mathematical mddel, wherein one of said values was determined in step (c).
- 9. The method as recited in claim 8, wherein said variables used in said second mathematical model represent filler level, basis weight and relative humidity.

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A method for manufacturing paper/paperboard, comprising the following steps:

- (a) manufacturing paper/paperboard product of a particular grade having a first set of respective values for a plurality of material properties that affect fracture toughness;
- (b) measuring the fracture toughness of said paper/paperboard product;
- (c) determining that the measured fracture toughness of said paper/paperboard product is different than a desired fracture toughness;
- (d) determining a second set of respective values for said plurality of material properties that will produce a fracture toughness closer to said desired fracture toughness; and
- (e) manufacturing paper/paperboard product of said particular grade having respective values for said plurality of material properties that are respectively substantially equal to said first set of respective values.
- 11. The method as recited in claim 10, wherein said measuring step comprising determining the essential work of fracture.
- one of said plurality of material properties is filler
 - 13. The method as recited in claim 11, wherein one of said plurality of material properties is softwood pulp content.
- 14. The method as recited in claim 11, wherein one of said plurality of material properties is caliper.

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- The method as recited in claim 11, wherein said step of determining a second set of respective values for said group of material properties is performed using a mathematical model of fracture toughness as a function of said plurality of material properties.
- 16. The method as recited in claim 15, wherein said mathematical model of fracture toughness is of the form:

$$FX = \beta_0 - \beta_1 x_1 + \beta_2 x_2 + \beta_3 z_2$$

- where x_1 is a function of filler level, x_2 is a function of softwood pulp content, z_2 is a function of caliper, and β_0 through β_3 are constants.
- 17. A method for operating a paper mill, comprising the following steps:
- manufacturing different grades of paper or paperboard;

measuring the fracture toughness of test samples of paper or paperboard taken from multiple production runs;

for each of a multiplicity of production runs, storing fracture toughness measurements and associated material property data in a databank

retrieving from said databank a set of material property data for a grade of paper or paperboard; and

- manufacturing a grade of paper or paperboard product having material properties that are respectively substantially equal to values in said material property data retrieved from said databank.
 - 18. The method as recited in claim 17, wherein each set of material property data comprises respective

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data for caliper, softwood pulp content and filler level of a respective grade of paper or paperboard.

19. A method for designing a grade of paper or paperboard, comprising the following steps:

performing a factorial experiment to investigate the effects of papermaking variables on in-plane fracture toughness of a grade of paper or paperboard;

analyzing data acquired by said factorial experiment to derive a statistically significant mathematical model for fracture toughness as a function of a plurality of material properties of said grade of paper or paperboard.

- 20. The method as recited in claim 19, further comprising the steps of selecting a desired fracture toughness for a grade of paper or paperboard to be manufactured and determining values for said plurality of material properties which, when input to said mathematical model, produce a calculated fracture toughness approximately equal to said desired fracture toughness.
- 21. The method as recited in claim 19, wherein said plurality of material properties comprise caliper, softwood pulp content and filler level.
- 22. The method as recited in claim 20, further comprising the steps of:

manufacturing a plurality of paper or paperboard products of a particular grade, each product having a different fracture toughness;

converting said products in a printing press;

acquiring data reflecting the press runnability performance of each of said products in said printing press; and

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determining an optimal range of fracture toughness based on acquired press runnability performance data,

wherein said desired fracture toughness is selected from said optimal range of fracture toughness.

- 23. The method as recited in claim 20, further comprising the step of manufacturing a paper or paperboard product having the material properties that were input to said mathematical model.
- 24. The method as recited in claim 20, wherein said mathematical model of fracture toughness is of the form:

$$FT = \beta_0 - \beta_1 x_1 + \beta_2 x_2 + \beta_3 z_2$$

where x_1 is a function of filler level, x_2 is a function of softwood pulp content, z_2 is a function of caliper, and β_0 through β_3 are constants.